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Geology of Grigg and Stobie Townships District of Sudbury

By

H. D. Meyn

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Geological Map

(back pocket)

Map 2238 (coloured) — Grigg and Stobie Townships, Sudbury District.
Scale, 1 inch to ½ mile.

ABSTRACT

This report describes the general, structural, and economic geology of Grigg and Stobie Townships, District of Sudbury, which together comprise approximately 74 square miles. The townships are located approximately 38 miles north-northeast of the city of Sudbury. All the bedrock is of Precambrian age, but large parts of the area are covered by Pleistocene sands and gravels and Recent swamp deposits.

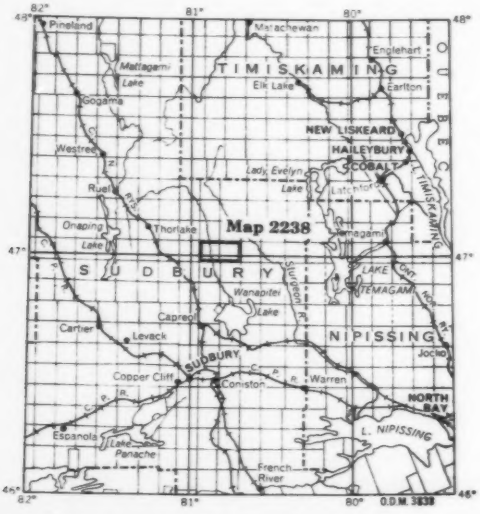

Figure 1–Key map showing location of Grigg and Stobie Townships. Scale, 1 inch to 50 miles.

The oldest rocks are Archean metavolcanics consisting of mafic schists, diabase, iron formation, and metasedimentary mafic and felsic schists. These rocks have been intruded by granitic rocks of predominantly quartz monzonite composition but ranging in composition from granite to granodiorite. Pegmatite dikes and pegmatitic areas are common. Gabbro and diabase dikes intruded the older rocks. The Archean rocks are unconformably overlain by, or in fault contact with Lower Proterozoic (Huronian) sedimentary rocks composed of quartzite, argillite, conglomerate, and limestone. These can be classified into the following formations: Mississagi, Bruce, Espanola, Serpent, Gowganda, and Lorrain. All the above rock types are intruded by dikes and sills of Nipissing quartz diabase and by olivine diabase.

The Archean metavolcanics and metasediments were folded and faulted prior to the intrusion of the granite. Schistosity and gneissosity are not common in the granite. The Proterozoic sedimentary rocks are folded strongly near major faults but only slightly away from them. The whole region has been block faulted. Minor structural elements such as jointing, quartz veins, and schistosity are moderately developed but lineations are absent.

The only mineralization of economic interest found in the map-area to date is uranium mineralization located at or near the base of the Proterozoic sedimentary sequence.

Geology
of
Grigg and Stobie Townships
District of Sudbury

by

H. D. Meyn[1]

INTRODUCTION

Grigg and Stobie Townships, together comprising approximately 73.8 square miles, lie about 38 miles north-northeast of the city of Sudbury, in the Sudbury Mining Division. The location is also indicated on the key map, Figure 1. During the 1968 field season, an Ontario Department of Mines field party under the direction of the writer mapped the two townships.

ACCESS

Access to the area is provided in the west by a very rough service road for the 500 K.V. transmission line of the Hydro-Electric Power Commission of Ontario. This road can be reached from Parkin or Fraleck Townships. The central part of the area can be reached by a well-maintained gravel road belonging to Portelance Lumber Limited. This road follows the east bank of the Wanapitei River in Grigg Township and it can be reached from Highway 545 about 4 miles north of Capreol. Access to the southeastern part of Stobie Township is provided by a gravel road belonging to The M. J. Poupore Lumber Company Limited. This road branches from the Portelance road in Fraleck Township. Some parts of the map-area are accessible only by float-equipped aircraft. Centre, Stobie, Barron, Alphretta, Frederick, and Dougherty Lakes are suitable for fixed-wing aircraft and many of the smaller, mostly unnamed lakes, can probably be used by helicopter.

MAPPING METHOD

The geological map of the area was prepared on two sheets at a scale of 1 inch to ¼ mile using base maps of the Forest Resources Inventory and air photographs supplied by the Silviculture Section, Ontario Department of Lands

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and Forests. Pace-and-compass traverses were made at suitable intervals between topographic points such as bodies of water, roads, and power lines. When the final map was prepared areas of outcrop between traverse lines were interpreted from air photographs.

The boundaries of the townships were not found, nor were any other surveyed lines found or used for orientation during the survey. To allow for the publication of the final map at the reduced scale of 1 inch to ½ mile some outcrop boundaries have been enlarged and generalized; this has led to some simplification.

ACKNOWLEDGMENTS

The author is indebted to the following persons and companies: Canadian Johns-Manville Company Limited for providing geological maps for much of Grigg and Stobie Townships; Portelance Lumber Limited and The M. J. Poupore Lumber Company Limited for use of their private roads. The author was ably assisted in the field by S. W. Burnie, R. S. Hewton, W. J. Kozak, P. A. Maynes, and J. W. Ponikvar. S. W. Burnie and R S. Hewton are responsible for about half the mapping.

PREVIOUS GEOLOGICAL WORK

W. H. Collins (1917, p. 4-7) describes the early geological and geographical work done in the area. In the same report Collins describes the work he did on the Onaping map-area which includes Grigg and Stobie Townships. A geological map at a scale of 1 inch to 4 miles is included with Collins' report. No geological work, known to the writer, was done in the area between 1917 and 1967 when the Canadian Johns-Manville Company Limited (1, 7) started uranium exploration in the two townships. Roberts, Creelman, Fraleck, Hutton, and Parkin Townships to the south and southwest of the Grigg-Stobie map-area were mapped by the author (Meyn 1970; 1971). Preliminary maps for the present map-area were published in 1969 (Meyn 1969a, b). Generalized geology of the map-area is included in compilation maps by the Ontario Department of Mines (Donovan 1965; Meyn 1966).

TOPOGRAPHY AND DRAINAGE

The topography of the region is typical for this part of the Canadian Shield; relief is low but the terrain is very rugged. The areas underlain by granite are moderate in relief and ruggedness, but the valley of the Wanapitei River is deeply incised and the sides of the valley are steep granite hills 300 feet high. The relief in the areas of Huronian sedimentary rocks is also quite low; swampy areas are common in areas of Gowganda rocks. Very rugged topography is found in areas underlain by post-Huronian diabase. North of Centre Lake is a park-like area of

gently undulating ground moraine with stands of yellow birch, probably the most scenic area in the two townships. In many other parts of the map-area, rock exposure is poor because of a cover of glacial and glaciofluvial material.

Lakes in the granitic terrain are small and many of them owe their present levels to beaver dams. In Stobie Township, Alphretta, Centre, and Fraleck Lakes are larger than other lakes of the map-area, and these lakes have exceptionally clear water. It is not unusual to see bottom at 40 feet and clearly distinguish objects to a depth of 20 feet. Frederick Lake appears to be the shallowest with depths over 50 feet being uncommon. The regional drainage pattern is to the southeast. The map-area is situated near the confluence of the watersheds separating the Great Lakes, the James Bay, and the St. Lawrence drainage systems and is, therefore, characterized by steep gradients and immature streams. Pleistocene glaciation has had a pronounced influence on the pre-Pleistocene drainage pattern. Many streams, which have been displaced and which are now establishing a new valley for themselves, are very immature, whereas other streams following major Pleistocene spillways are underfit. Both types of streams are full of alternating rapids and pools which make canoe travel difficult. The valley of the Wanapitei River is up to 300 feet deep. Even if the rock in the present valley had been weakened by a fault it seems unlikely that the whole of the present valley is a Pleistocene feature; the Wanapitei valley probably was a pre-Pleistocene drainage channel.

NATURAL RESOURCES

Some of the lakes of the map-area can be reached by private roads. Pike, pickerel, trout, and bass are found in the lakes, but stocks, especially of trout, have been depleted by fishing. Alphretta Lake, locally called Paradise Lake, has a fine sand beach, improved by bulldozer work. The beach is now about 1,000 feet long and 30 feet wide. Winter access provided by the snowmobile has made possible year-round recreational enjoyment of the area.

Pulpwood and timber cutting has been carried on in Stobie Township in recent years. The timber stands are commonly second growth jack pine, spruce, or mixed poplar, birch, pine, and spruce. Cedar and alder are found in swampy areas and oak and maple on some hills. Only small stands, or individual trees, of the original growth, often white pine, are found in inaccessible areas.

There are no mines or quarries in the area. Occurrences of uranium-bearing rocks were drilled in 1967 and 1968 in Grigg Township. No other mineralization was found or has been reported in the map-area.

GENERAL GEOLOGY

The map-area is underlain by Precambrian rocks. Archean rocks consisting of metavolcanics intruded by granite and dikes form the basement for the Huronian sedimentary rocks. The latter are separated from the Archean by the Great Unconformity. Intrusion of quartz diabase sills and dikes and olivine diabase dikes are the latest Precambrian events. Most of the map-area is covered

Table 1 | TABLE OF LITHOLOGIC UNITS FOR GRIGG AND STOBIE TOWNSHIPS

CENOZOIC

RECENT

Fluvial clays and silts, swamp deposits

PLEISTOCENE

Clay, sand, gravel, till

Unconformity

PRECAMBRIAN

PROTEROZOIC

LATE MAFIC INTRUSIVE ROCKS

OLIVINE DIABASE

Olivine diabase

Intrusive Contact

NIPISSING DIABASE

Quartz gabbro, quartz diabase

Intrusive Contact

HURONIAN SUPERGROUP

COBALT GROUP

LORRAIN FORMATION

Sandstone, argillite, conglomerate

Faulted Contact, Conformable Contact

Gowganda Formation

Argillite, siltstone, greywacke, arkose, quartzite

Unconformity, Local Conformity and Disconformity

BRUCE GROUP

SERPENT FORMATION

Sandstone, calcareous sandstone

ESPANOLA FORMATION

Limestone, marble, interbedded siltstone

BRUCE FORMATION

Conglomerate

MISSISSAGI FORMATION

Quartzite, argillite, conglomerate

Great Unconformity, Faulting

ARCHEAN

EARLY MAFIC INTRUSIVE ROCKS

Metadiabase and diabase, amphibolite

Intrusive Contact

GRANITIC ROCKS

Pink and grey quartz monzonite, granite, granodiorite; pegmatites

Intrusive Contact

FELSIC METAVOLCANICS OR METASEDIMENTS

Felsic schists of metavolcanic or metasedimentary origin

MAFIC TO INTERMEDIATE METAVOLCANICS AND ASSOCIATED METASEDIMENTS

Mafic metavolcanics, schist, diabase and metadiabase

with a discontinuous veneer of Pleistocene deposits. In old drainage channels and outwash areas the Pleistocene deposits are quite thick. Swamps cover much of the low ground.

Radiometric age determinations made in the Sault Ste. Marie to Cobalt region by a number of investigators indicate that the age of the granitic rocks are approximately 2,500 m.y. (Van Schmus 1965; Fairbairn *et al.* 1960), that the Huronian sediments are from 2,100 to 2,400 m.y. (Van Schmus 1965; Fairbairn *et al.* 1967; Fairbairn *et al.* 1969), that the Nipissing Diabase is about 2,160 m.y. (Van Schmus 1965; Fairbairn *et al.* 1969), and that the olivine diabase dikes were intruded about 1,100 m.y. ago (Fairbairn *et al.* 1960; Van Schmus 1965).

The rock units of the area are shown in the Table of Lithologic Unit (Table 1).

ARCHEAN

Mafic to Intermediate Metavolcanics and Associated Metasediments

The oldest rocks of the map-area are mafic to intermediate massive rocks and schists. Small areas of these rocks are present throughout the granitic terrane of the map-area; a large area is found in the northwestern part of Stobie Township. About 30 percent of the pre-granitic rocks are metavolcanic or metasedimentary schists with a predominantly northeasterly, vertical foliation. Of the remaining 70 percent, very little is composed of massive flow rocks but rather of mafic rocks with diabasic texture (hypabyssal intrusions) which vary in grain size from fine to coarse. Mineral assemblages of amphibole, plagioclase (albite to andesine), epidote, biotite, quartz, and magnetite indicate a metamorphic grade in the upper greenschist to lower almandine-amphibolite facies (see Table 2, Nos. 1, 2, for modal analyses). In some outcrops, the metadiabase is interbedded with the schist; in one outcrop, it cut the schist and in another it was cut by pegmatite (Photo 1), but, in most outcrops of the metadiabase, age relationships are not clear. It is, therefore, possible that some Nipissing Diabase was included with the older diabase during the mapping.

Felsic Metavolcanics or Metasediments

Parts of the Archean schist complex contain felsic schists. Commonly these are interbedded with the mafic schists. Only one lens, located in northwestern Stobie Township is large enough to be shown on the map. Here, the schist is a biotite-quartz and biotite-quartz-feldspar schist with up to 70 percent quartz with a grain size of 0.01 mm. This schist may be a metasediment.

Table 2 MODAL ANALYSES OF PRE-HURONIAN ROCKS FROM GRIGG AND STOBIE TOWNSHIPS
(Values in percent)

Analysis Number	Rock Type and Sample Number	Quartz	Plagioclase	K-Feldspar	Amphibole	Biotite	Epidote	Granophyre	Magnetite	Pyrite	Sphene	Chlorite	Zircon	Apatite	Fluorite	Plagioclase Composition
	Metadiabase in metavolcanics															Albite
1	MS-68-19	5	20	...	30	45	...	...	...	...	...	...	...	...	...	$An_{40 \pm 5}$
2	MS-68-60	...	30	...	70	x	x	x	x	...	...	...	...	...	...	
	Albite trondhjemite to trondhjemite															Albite
3	MS-68-44	45	51	1	...	3	...	...	...	...	...	x	x	...	...	
	Quartz monzonite (typical pink granite)															$An_{37 \pm 5}$
4	BG-68-1	27	37	31	...	5	...	...	x	x	x	x	...	x	...	
	Albite granodiorite (typical grey granite)															Albite
5	BG-68-2	29	52	15	...	2	...	...	x	...	x	2	x	x	...	
	Albite quartz monzonite															Albite
6	BG-68-8	40	25	30	...	5	x	...	x	...	...	x	...	x	x	
	Post-granitic metadiabase															$An_{55 \pm 5}$
7	MG-68-7	7	24	...	58	4	x	...	2	...	5	...	...	...	...	

x denotes less than 1 percent of mineral present.

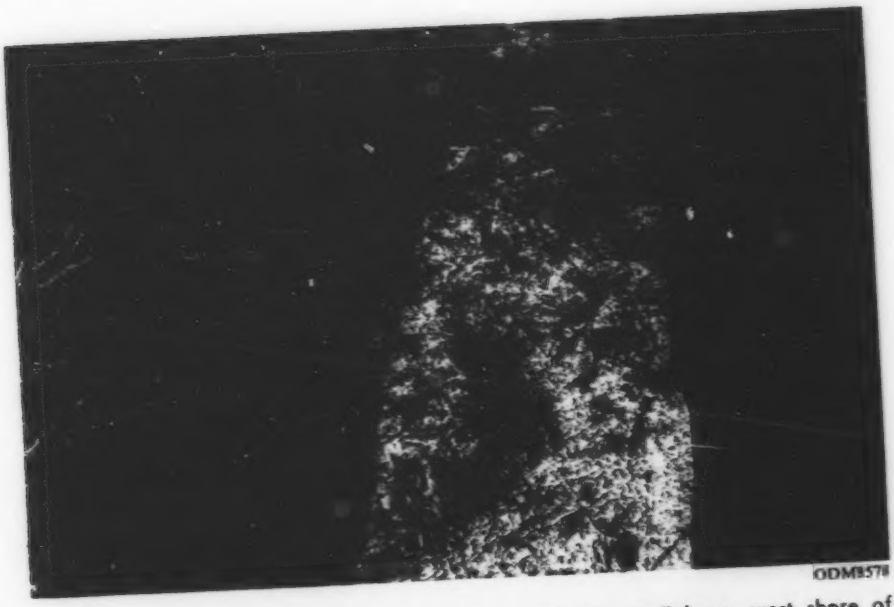


Photo 1—Pegmatite dike intruded into medium-grained metadiabase; west shore of Stobie Lake, Stobie Township.

Granitic Rocks

Three-quarters of Grigg Township and a few areas in the northwestern part of Stobie Township have outcrops of granitic rocks. These rocks are fine to medium grained, pink weathering, and equigranular with pegmatitic areas and pegmatite dikes. They vary in composition from quartz monzonite and granodiorite and albite trondhjemite (see Table 2, Nos. 3, 4, 5, 6 for modal analyses). The granodiorite is found primarily in grey phases caused by assimilation of mafic pre-granitic rocks with the resultant formation of additional mica. The inclusions are partly digested amphibolites, with gossan stains and randomly oriented foliations. Jointing is not widespread but is present locally. Foliated granitic rocks were observed especially near shears, but no true granitic gneiss was seen. Locally, hematite concentrations around quartz crystals or grains give the rock purple spots.

A conspicuous feature of the granitic rocks are the large number of pegmatite dikes and pegmatitic areas in it. Most dikes are less than 1 inch thick. The pegmatitic areas may extend over areas up to ½ square mile. A pegmatite dike, 12 inches thick, has quartz crystals up to 3 inches long in the centre and ½ inch long near the margin. Biotite, in books up to 1 inch thick, predominates near the margins.

The granitic rocks vary in composition from quartz monzonite to granodiorite and albite trondhjemite (see Table 2, Nos. 3, 4, 5, 6 for modal analyses).

The degree of alteration is locally quite high with epidote, biotite, chlorite, quartz, and albite constituting the mineral assemblage and with the original texture eliminated. This is not evident from Table 2 because modal analyses were not done for these highly altered rocks.

Early Mafic Intrusive Rocks

The granitic rocks, and possibly the metavolcanics, are intruded by mafic dikes. There are a number of types. The outcrop of early mafic intrusions in west-central Grigg Township is a metagabbro which has black porphyroblasts (½ cm in diameter) consisting of hornblende and biotite around sphene after ilmeno-magnetite. One dike, only 2 inches wide, is strongly magnetic, fine grained (0.1 mm), and composed of plagioclase ($An_{63}\pm_5$) and pyroxene with a small percentage of finely dispersed magnetite. Most numerous are diabase dikes that are now amphibolites. Again, a correlation problem is encountered with these metadiabase dikes and they can be classified as post-granitic only when they have intruded the granite. A modal analysis of a typical metadiabase dike is given in Table 2, No. 7. These metadiabase dikes seem to be post-granitic and pre-Huronian in age. This would indicate that they may be equivalent in age to the Matachewan dikes of the Matachewan area (Lovell 1967), but at the writing of this report, there is not sufficient petrographic or structural evidence, nor are there any radiometric age determinations to support such a correlation.

PROTEROZOIC

Huronian Supergroup

In the area northeast of Sudbury, Collins (1917) does not report any Bruce Series rocks but recent mapping has confirmed their presence (Thomson 1960; Meyn 1970; 1971). If the time-stratigraphic term "Series" is replaced with the rock-stratigraphic term "Group", the stratigraphic column of Collins (1925, p. 17) is probably the most useful one for the map-area and the area northeast of Sudbury. The abundant stratigraphic detail revealed by recent geological investigation along the north shore of Lake Huron (Robertson 1967, Fig. 6; Robertson *et al.* 1969) is not present northeast of Sudbury. Also, it has been customary in the past to refer to Huronian formations with combination names such as Mississagi quartzite, Bruce conglomerate, etc. (Collins 1917, p. 17). This practice has been abandoned because only a few individual formations actually have the lithology indicated by their combination names. The use of the term "Huronian Supergroup" follows the recommendation by Robertson, Frarey, and Card (1969).

All Huronian sedimentary rocks have been metamorphosed to some degree and should, therefore, carry the prefix "meta", but for simplicity this will not be done.

A number of conglomerates in the Huronian sedimentary rocks vary considerably in the size of the clastic fragments. In this report, the term "megaclasts"

when used in the description of a conglomerate refers to clastic fragments greater than 1/8 inch in diameter. When the size of the megaclasts corresponds to that of pebbles, cobbles, or boulders the appropriate term will be used. The fragments of the matrix of these conglomerates are described as clastic grains.

BRUCE GROUP

Mississagi Formation

The Mississagi Formation in Grigg Township forms a belt that parallels the Wanapitei River. In central Grigg Township this rock belt turns eastward. Several small discontinuous areas of the Mississagi Formation are found in west-central Stobie Township and near Stobie Lake. The thickness of the Mississagi Formation is estimated to be approximately 1,000 feet in the central Grigg Township occurrences. In the map-area, the Mississagi Formation includes all rocks between the underlying Archean basement rocks and the overlying conglomerates of the Bruce Formation, because a mappable subdivision was not found possible. Thus, in the map-area, Mississagi Formation is used according to Collins (1925, p. 17) and includes the rocks similar to the Hough Lake Group and the Elliot Lake Group of the north shore area of Lake Huron (Robertson *et al.* 1969).

The unconformity with the underlying rocks was not seen in Grigg Township except north of the big bend in the Wanapitei River, at the south boundary of Grigg Township, where the contact is a vertical shear zone. Here and northward, the Mississagi Formation consists of a buff to cream weathering, medium- to thick-bedded, and crossbedded quartzite. Dips are approximately vertical; tops face east; maximum stratigraphic thickness is about 800 feet.

A large exposure of Mississagi Formation is located just east of the Wanapitei River in central Grigg Township. Near the river, the lowermost unit exposed is a radioactive conglomerate consisting of sheared angular megaclasts of feldspar and quartz about 1/4 inch in size, in a sheared, black, very fine grained argillaceous matrix. This conglomerate is part of about 100 feet of uranium-enriched sediments, predominantly composed of conglomerates, that grade upwards into quartz-pebble conglomerates and laterally, in a northeasterly direction, into siltstone interbeds. Radioactivity is low and sporadically distributed throughout this basal sequence but concentrated near the base and not in the stratigraphically higher quartz-pebble conglomerates. This sequence is overlain by typical dark grey to cream arkosic quartzite of the Mississagi Formation.

A single outcrop of Mississagi Formation near the eastern boundary of Grigg Township is evidence of preservation in that area of at least some Bruce Group rocks beneath the pre-Gowganda unconformity.

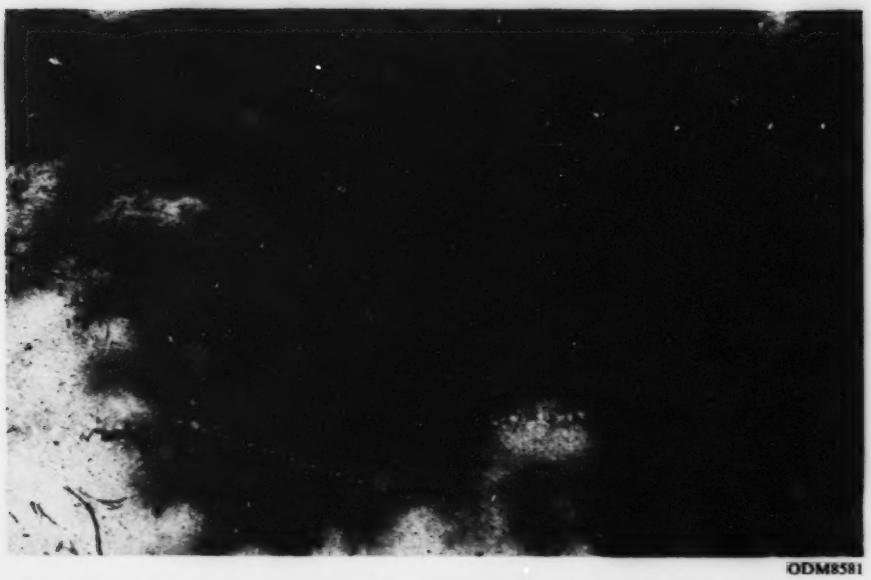
Further east in the west-central section of Stobie Township, an area of Mississagi Formation outcrop is present. Here, the Mississagi is a pink to dark grey weathering, rusty, medium-grained sandstone with argillaceous bedding-plane partings and argillaceous interbeds up to 18 inches thick. Beds range in thickness from 1/10 to 1 inch and locally are graded, crossbedded, or both.

ODM8579

Photo 2–Soft sediment deformation in basal Mississagi Formation; southeast shore of Stobie Lake, Stobie Township.

ODM8580

Photo 3–Large angular fragments of vein quartz in a gritty matrix, Mississagi Formation; southeast shore of Stobie Lake, Stobie Township.



ODM8581

Photo 4—Single-pebble conglomerate bed in siltstone at the base of the Mississagi Formation; southeast shore of Stobie Lake, Stobie Township.

A very interesting outcrop area of Mississagi Formation rock is found on the southeast shore of Stobie Lake. Here the contact between the pre-Huronian granitic rocks and the Mississagi Formation again appears to be a vertical, sheared and brecciated zone. The granitic rocks seem to have been weathered and soft when the Huronian sediments were deposited (Photo 2). Subsequently, this contact was sheared and brecciated. The contact zone, which may be 5 feet thick, is overlain by an argillite unit 3 to 15 feet thick. Locally, the argillite grades laterally into conglomerate. This conglomerate contains angular quartz megaclasts (vein quartz) up to 4 inches along the longest edge in a quartz greywacke matrix with a very high percentage of pyrite and some chalcopyrite (Photo 3). A sample of this matrix analyzed by the Laboratory and Research Branch of the Ontario Department of Mines and Northern Affairs shows 7.86 percent iron, 0.021 percent uranium oxide, traces of chromium, cobalt, copper, lead, manganese, nickel, thorium, vanadium, about 0.25 percent of zirconium, and about 0.50 percent of titanium. The uranium mineralization present near this contact is in a sheared, pyritiferous argillite about 1 to 3 feet thick. Uranium oxide equivalents of beta-ray activity determined by the Laboratory and Research Branch of the Ontario Department of Mines and Northern Affairs shows 0.08 percent U_3O_8 in a sample of the sheared argillite. Above the argillite, a siltstone, with a few pebbles up to ¾ inch in size (Photo 4), grades over 50 to 80 feet into quite typical, medium-grained, white to cream weathering Mississagi quartzite 20 to 30 feet thick. From the granitic rock contact to the top of the quartzite unit, the total thickness is about 120 feet.

Table 3 MODAL ANALYSES OF HURONIAN SEDIMENTARY ROCKS FROM GRIGG AND STOBIE TOWNSHIPS
(Values in percent)

Analysis Number	Formation and Sample Number	Quartz	Plagioclase	K-Feldspar	Carbonate	Zircon	Monazite	Pyrite	Biotite	Epidote	Sphene	Apatite	Matrix	Remarks
	Mississagi													
1	MS-68-21	21	2	•	...	4	...	1	...	...	...	...	72	Radioactive argillite
2	MS-68-26	22	x	•	...	11	...	23	...	...	...	...	44	Radioactive argillite
3	MS-68-87	31	4	•	...	6	...	2	...	...	...	...	57	Siltstone
4	MS-68-25	56	4	16	...	...	...	...	...	...	...	...	24	Quartzite
5	MS-68-40	54	1	17	...	x	...	x	x	...	x	...	28	Quartzite
6	MS-68-38	33	.5	•	...	...	11.5	...	...	...	...	...	55	Greywacke
7	MS-68-65	58	2	13	...	...	...	...	x	...	...	...	27	Quartzite
8	MG-68-19	22	...	...	...	...	1	2	...	...	...	...	75	Argillaceous radioactive conglomerate
	Bruce													
9	MS-68-24	28	8	5	x	...	...	x	8	...	...	...	51	Matrix of Bruce conglomerate
10	MG-68-18	35	1	3	...	...	...	...	5	...	...	...	56	Matrix of Bruce conglomerate
11	HG-68-10	39	15	27	...	...	...	x	5	x	x	...	14	Matrix of Bruce conglomerate
	Serpent													
12	HG-68-9	36	11	13	...	...	...	x	4	...	...	x	36	
13	MG-68-9	42	5	10	4	x	...	x	...	...	...	...	39	
14	MG-68-10	40	9	19	11	x	...	x	x	...	x	...	21	
15	MG-68-12	37	2	10	...	...	...	x	3	...	...	...	48	
16	MG-68-13	34	5	29	x	...	...	x	...	...	...	...	32	
17	MG-68-26	36	5	17	32	...	...	...	...	...	...	...	10	
18	BG-68-16	48	12	30	7	x	...	...	...	...	...	x	3	
19	BG-68-27	48	9	21	8	x	...	x	...	...	...	...	14	
	Gowganda													
20	MS-68-90	30	8	2	2	...	...	x	3	...	...	...	55	Matrix of a 20% pebble conglomerate
21	MS-68-34	75	6	19	...	x	...	x	...	...	x	x	...	Mosaic texture with no matrix
22	BS-68-39	75	5	20	...	...	...	...	...	...	...	...	...	Mosaic texture with no matrix
	Lorrain													
23	MS-68-7	65	8	10	...	x	...	x	x	...	...	...	17	
24	MS-68-4	62	3	19	...	...	...	...	...	...	...	...	16	
25	BS-68-3	56	2	16	...	...	...	...	...	...	...	...	26	
26	BS-68-8	56	4	15	...	...	...	...	...	...	...	...	25	

• K-Feldspar included with the plagioclase in this sample.
x denotes less than 1 percent of mineral present.

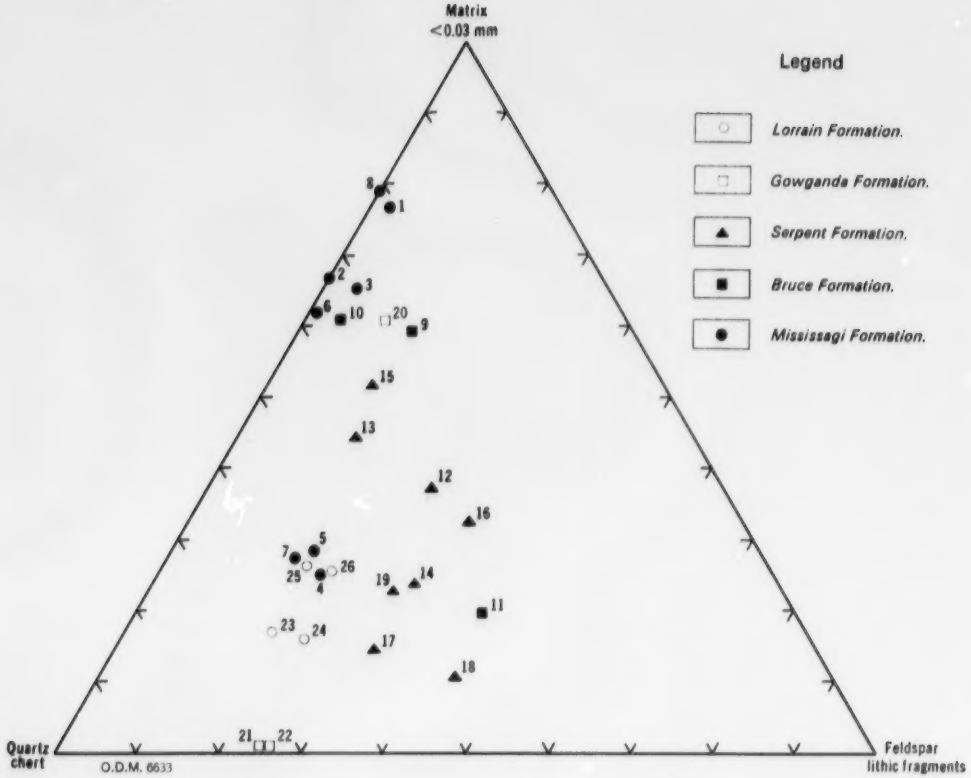


Figure 2–Mineralogical composition of Huronian sedimentary rocks, Grigg and Stobie Townships. Positions of samples No. 2, 6, 14, 17 were recalculated for this figure disregarding zircon, pyrite, monzonite, and carbonate.

To the south towards the small unnamed lake, the quartzite unit thickens to about 600 feet. Just north of this lake, a section across the quartzite starts with a greenish grey weathering, black, quartz-rich, medium-grained greywacke with pebble beds with angular pebbles up to ½ inch in size. Beds range in thickness from 1 to 6 inches in interbedded argillaceous and medium- to coarse-grained sandstone. Higher in the section there are some rusty beds and 100 feet up in the section the rock is a coarse-grained, crossbedded light grey, arkosic quartzite with siltstone and argillite interbeds.

West and south of Stobie Lake there are two other outcrop areas of Mississagi rocks that are similar to those described above with argillite, quartzite, and conglomeratic interbeds (see Table 3, Nos. 1-8 for modal analyses of Mississagi Formation rocks and Figure 2).

The rocks of the Mississagi Formation were probably deposited in a continental fluvial environment. One must probably imagine a treeless and plantless plain over which many rivers meandered freely and probably braided to some extent, spreading deposits fairly evenly over a large area. The uranium-bearing sediments seem to have been deposited in the low-lying areas, probably the river beds.

Bruce Formation

The Bruce Formation is present in Grigg Township and overlies the quartzite of the Mississagi Formation conformably. Maximum stratigraphic thickness exposed is approximately 1,500 feet. No Bruce Formation was seen in Stobie Township but rocks very similar to typical Bruce conglomerate were found directly overlying the Mississagi Formation. These have been mapped as Gowganda Formation because they grade imperceptibly into rocks typical of the Gowganda Formation.

The Bruce Formation in Grigg Township is typically composed of subrounded to subangular megaclasts from ½ inch to 24 inches in size in a fine-grained matrix. The megaclasts range from 2 to 60 percent of the rock, but average about 5 percent and are composed predominantly of white granite, but white quartz, siltstone, chert, and metavolcanics are also represented. The matrix of the conglomerate weathers dark to medium grey, and on the fresh surface is light to medium grey with rusty staining resulting from the weathering of pyrite cubes. No other sulphides were observed. This matrix is a clastic sedimentary rock, whose grains range in size from 0.05 mm to 3.0 mm and are quartz and slightly altered feldspar in a fine-grained matrix of quartz, feldspar, and sericite (see Table 3, Nos. 9, 10, 11, for modal analyses of the matrix and Figure 2).

The unstratified, poorly sorted appearance of the rock, and mixture of lithologies in the subangular to subrounded megaclasts, the rafted pebbles reported from the township to the south (Meyn 1971), and its widespread distribution and thickness suggest a glacial origin for the formation.

Espanola Formation

Regionally, the Espanola Formation conformably overlies the Bruce conglomerate but the contact was not seen in outcrop in the map-area. For the map-area, the Espanola Formation is defined as the sequence of interbedded siltstone and limestone which overlies the Bruce Formation with a total stratigraphic thickness of about 150 feet. The formation is present in the belt of north-south-trending sedimentary rocks that parallel the Wanapitei River in south-central Grigg Township. On the basis of a lithologic and stratigraphic comparison, it is this formation which was called Bruce limestone (Collins 1925, p. 47-51) in the Blind River area.

In the map-area, the Espanola Formation is composed of limestone layers ¼ to ¾ inches thick, interbedded with siltstone layers 1/10 to ¼ inches thick. The limestone is quite pure in many localities consisting of clastic grains of calcite, but in others it is recrystallized and dolomitized.

The rock was probably deposited under nearshore quiescent conditions. The thin laminations suggest seasonal variation. The carbonate may be mostly chemically or biochemically precipitated, but the siltstone interbeds are of clastic origin.

Serpent Formation

For the map-area, all sedimentary rocks between the Espanola Formation and the Gowganda Formation have been designated Serpent Formation. Regionally, the Serpent Formation overlies the Espanola Formation conformably. It is present in the north-south belt of Huronian rocks in the southeast quadrant of Grigg Township, but dies out when the strike of these sedimentary rocks turns eastward. Maximum stratigraphic thickness in the map-area is about 1,700 feet.

The Serpent Formation consists of clastic sedimentary rocks that are medium to light grey weathering, thin to medium bedded and crossbedded, and locally carbonate-rich (Photo 5). They are medium grained with subrounded to subangular grains of quartz and feldspar in a fine-grained matrix of quartz, feldspar, carbonate, and mica, with accessary pyrite, zircon, sphene, and leucoxene. In some beds, carbonate is the only matrix material present. In most thin sections, the carbonate appears as clastic grains in the matrix. In some, however, recrystallized carbonate is the only matrix and it was impossible to determine whether it was originally a chemical or mechanical sediment (see Table 3, Nos. 12-19 for modal analyses and Figure 2). The carbonate-rich rocks seem to be concentrated just above the Espanola Formation, but a sample carrying 8 percent carbonate was found within 15 feet of the top of the formation, and similarly carbonate was found at intervals all through the formation. Three crossbedding measurements show source directions from S40W, N80E, and east.

The Serpent Formation was probably deposited in an environment similar to that of the Mississagi Formation.

ODM8582

Photo 5–Crossbedding in calcareous basal Serpent Formation; south-central Grigg Township.

COBALT GROUP

Gowganda Formation

The Gowganda Formation overlies the Serpent Formation and, where the latter is not present, the older rocks. There is local evidence for unconformable and conformable contacts with the underlying Serpent Formation. The total stratigraphic thickness of the Gowganda Formation could not be determined because an undisturbed sequence is not available but the author's estimate is a minimum of 5,000 feet and a maximum of 14,000 feet.

In northern Stobie Township, a contact of the Gowganda Formation with the granitic rocks is covered by a 10-foot wide strip of overburden on the side of a hill. It seems to be a sheared, near-vertical contact that could well be a sheared and folded unconformity. At one locality in south-central Grigg Township, a gradational contact between the Serpent and the Gowganda Formations was observed. Here, the top of the Serpent Formation ranges from a medium grey, medium-grained, grey weathering, fairly clean sandstone to a sparse conglomerate with angular to rounded megaclasts from ¼ to 6 inches in diameter. These megaclasts constitute about 5 percent of the rock, are in a greywacke matrix, and consist of white granite, chert, and quartzite. The Serpent sandstone grades upward into typical Gowganda conglomerate comprising 80 percent megaclasts ¼ to 6 inches in diameter, of salmon-pink granite, grey granite, quartzite, siltstone, chert, iron formation, diabase, greenstone, and porphyritic granite. The matrix of this conglomerate is an argillaceous greywacke.

The sedimentary rocks of the Gowganda Formation are composed of many lithologies that appear to grade into each other both laterally and vertically over very short distances. It was thought that a grouping of the formation into three lithologic classes, bedded argillite, bedded sandstone, and conglomerate, with each class theoretically representing a distinct depositional environment, might help to show large-scale, mappable features in the formation. This did not prove satisfactory, but there is a general vertical trend in the predominance of rock types in the Gowganda Formation from coarse-grained rocks (boulder conglomerates) near the base to fine-grained rocks (argillites) near the top; this trend is, however, modified by two or three cycles, each with a decreasing range in grain size.

About 5 percent of the Gowganda Formation is composed of a polymictic paraconglomerate with a fine- to coarse-grained, argillaceous to quartzitic, unstratified matrix with more than 20 percent megaclasts. The megaclasts may amount to 90 percent of the rock; they range in size from ¼ inch to 2 feet, and are composed of pink granite, grey granite, siltstone, white quartz, metavolcanics, gabbro, diabase, chert, and argillite. The matrix is black to grey-green in the fine-grained rocks, grey in the medium-grained rocks, and cream in the arkosic rocks.

About 30 percent of the Gowganda Formation is composed of paraconglomerate with less than 20 percent megaclasts ranging in size from ⅛ to 4 inches of the same lithologies as the above-mentioned paraconglomerate. The matrix is commonly a dark grey weathering, unstratified, argillaceous sandstone.

A further 5 percent of the Gowganda Formation is made up of greywacke, arkose, and sandstone. True quartzite was observed only locally. A pink weathering, medium-bedded (2-15 inches) arkose is present in a number of places such as around the north half of Stobie Lake. Beside the creek between Barron Lake and Alphretta Lake, a pink weathering arkose containing 60 to 70 percent feldspar is present. In the arkose sequence, there are interbeds of conglomerate, 1 to 2 feet thick, containing 70 percent pebbles of which 80 percent are pink granite. A pink weathering arkose is present at the top of the Gowganda Formation in Fraleck Township (Meyn 1971) but this was not observed in the map-area. At Frederick Lake, where the contact with the Lorrain Formation is gradational, a grey crossbedded sandstone, alternately thin-bedded (7/10 to 3/10 inch) and medium-bedded (¼ to 10 inches), is present at the top of the Gowganda Formation.

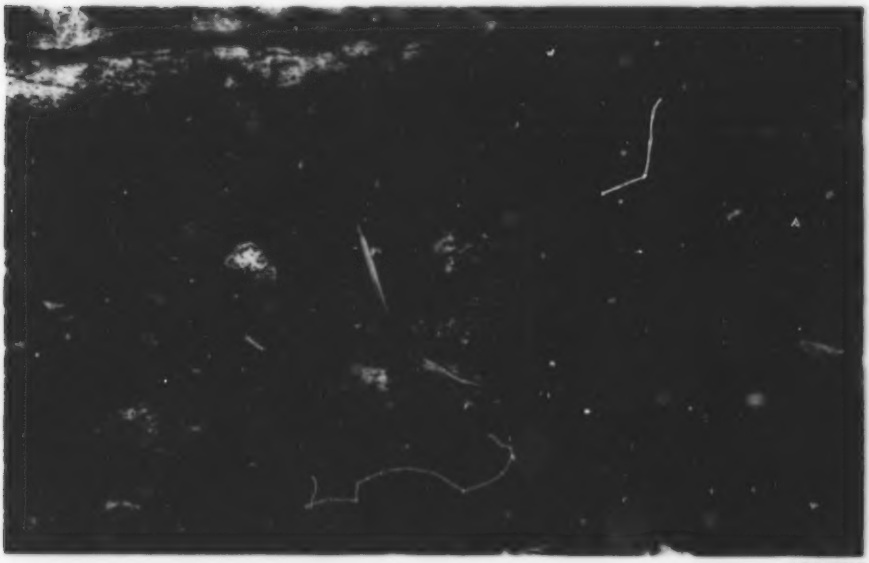
The remaining 60 percent of the Gowganda Formation is composed of fine-grained, thin-bedded argillite and siltstone. These rocks are commonly very thinly bedded and locally crossbedded on a microscopic scale (1 to 10 mm). The argillite is black and dark grey and the siltstone light grey to cream. In many places, argillite and siltstone are interbedded giving the rock a very striking appearance (Photo 6). When the argillite has no siltstone interbeds, it appears massive in outcrop because the bedding cannot be seen, but examination in thin section reveals bedding and often graded bedding which can be used to tell tops (Photo 7). In all thin sections examined, these fine-grained rocks show a bimodal distribution of clastic quartz and feldspar grains (0.05 to 0.1 mm) in a much finer grained matrix (0.001 to 0.02 mm) of quartz, feldspar, sericite, and locally magnetite (see Table 3, Nos. 20, 21, 22 for modal analyses and Figure 2). Rafted pebbles are quite common and may amount to 2 or 3 percent of the

ODM8583

Photo 6–Interbedded argillite, dark grey, and siltstone, light grey, in the Gowganda Formation; Centre Lake, Stobie Township.

ODM8584

Photo 7–Photomicrograph of thin-bedded argillite of the Gowganda Formation; northeast of Stobie Lake, Stobie Township. Note that grain gradation can be used to identify tops. (Total width of print represents 5 mm).



ODM8585

Photo 8–Compaction boudinage and rafted pebbles in argillite and siltstone of the Gowganda Formation; north-central Stobie Township.

rock (Photo 8). There is a complete gradation from this stratified rock with rafted pebbles to the mudstone conglomerate which has less than 20 percent megaclasts in an unstratified matrix. Some of the argillites (Photo 7) contain up to 9 percent magnetite causing an aeromagnetic anomaly as shown on Geological Survey of Canada Aeromagnetic Maps 1512G and 1513G (GSC 1965a, b) and as discussed in the section "Correlation between Geology and Geophysics." Locally, metamorphic remobilization has resulted in small lenses and veinlets of magnetite generally less than 1 mm thick and 10 mm long.

Pyrite cubes, up to 6 mm across, are ubiquitous in the fine- and medium-grained argillite and argillaceous rocks.

A glacial environment is proposed for the origin of the Gowganda Formation because the sediments varied from poorly sorted, unstratified material to well-bedded, water-laid, stratified drift material. Particularly diagnostic are rafted pebbles. This agrees with the concept proposed by a number of authors (Coleman 1907; 1908; Collins 1917, p. 30-34; 1925, p. 63-73; Schenk 1965; Lindsey 1969).

Lorrain Formation

Rocks of the Lorrain Formation are only found in the eastern half of Stobie Township. The major part of the outcrop is in the southeastern corner of the township. Small areas are found parallel to Balsam Creek, just east of Centre Lake, and along the east side of the northern half of the township. Only a few

hundred feet of the Lorrain Formation are exposed and the total stratigraphic thickness of the formation could not be determined.

On the east side of Frederick Lake light grey weathering sandstone of the Gowganda Formation grades into the Lorrain Formation. A similar sandstone is present on the southeast shore of Alphretta Lake, but here the lowermost part of the Lorrain Formation seems to be missing and the strikes are also unconformable indicating an unconformity or a fault.

At the base of the Lorrain Formation argillite-siltstone beds up to 6 inches thick predominate over quartzitic ones but these beds decrease in thickness and frequency and are reduced to bedding-plane partings in the upper part of the formation. In many outcrops, the quartzite is crossbedded and shows graded bedding, or even graded crossbeds. Top determinations can thus be made. Numerous pebble beds, 2 to 3 inches thick, with pebbles from ¾ to 1½ inches in diameter, making up from 3 to 20 percent of the individual beds, are present. The pebble lithologies are opalescent quartz, milky quartz, pink feldspar, smoky quartz, and greenish argillite. White spots, up to 3 mm in diameter, in these rocks in the Centre Lake area indicate the metamorphic development of andalusite. Similar spots seen in rocks north of Fraleck Lake in Fraleck Township (Meyn 1971) were identified by microscopic and x-ray investigation as andalusite.

The typical Lorrain quartzite is composed of clastic subrounded to subangular grains of quartz (0.03 to 3 mm) in a fine-grained matrix (0.001 to 0.03 mm) of quartz, feldspar, and sericite. Pink colour is partly due to feldspar grains and partly to hematite staining.

To determine paleocurrent directions 15 measurements of crossbedding directions were taken in the area northeast of Frederick Lake and the results indicate predominant transport to have been from the east (see Table 3, Nos. 23-26 for modal analyses of Lorrain quartzite and Figure 2).

The sediments of the Lorrain Formation were probably derived from rocks of granitic composition, transported a considerable distance, and deposited in an offshore but turbulent environment.

Late Mafic Intrusive Rocks

NIPISSING DIABASE

The Huronian rocks are intruded by a quartz-bearing gabbro that is commonly referred to as the Nipissing Diabase. The quartz-bearing gabbro occurs as a number of large and small sill-like and dike-like bodies in the map-area. The largest one is a sill-like body with a north-south trend in the northeastern part of Stobie Township; a smaller one, also with a north-south trend is in the western half of the township, and a third very small one is present in central Grigg Township. A few small plugs and a small dike are present in other parts of the map-area. It is likely that bodies of the quartz-bearing gabbro intrude pre-Huronian rocks, but it is difficult to distinguish the quartz-bearing gabbro from pre-Huronian diabases, therefore mafic intrusions in pre-Huronian rocks in the map-area have almost always been mapped as pre-Huronian in age.

At the southeast end of Frederick Lake a quartz-bearing gabbro intrusion overlies Gowganda Formation. The contact between the two rock units is not parallel to the strike of the Gowganda Formation and therefore this sill-like body seems to have intruded the Gowganda at a slight angle. In other places, such as the outcrop just east of the Centre Lake Fault southeast of Centre Lake, the contact between the Nipissing Diabase and the older rocks is near-vertical, probably due to postdepositional tectonism.

The typical quartz-bearing gabbro is a medium grey to black weathering, medium-grained but locally fine- or coarse-grained, rock. It is composed of amphibole, plagioclase ($An_{55}\pm_s$), quartz, chlorite, magnetite, sphene, biotite, saussurite, epidote, and micrographic intergrowths of quartz and feldspar. The amphibole is green, pleochroic, fibrous tremolite-actinolite after pyroxene, with reaction rims of blue-green sodic hornblende. The plagioclase is present in laths from 1 to 10 mm long. The texture of the rock varies from diabasic to hypidiomorphic granular and does not appear to have been ophitic. Interstitial magnetite forms up to 7 percent of the rock. Chlorite, biotite, saussurite, and epidote appear to be metamorphic products. There are two kinds of micrographic intergrowths. One is pseudomorphic after plagioclase and is probably composed of quartz and albite; the other appears to be intergrowths of quartz and orthoclase. In sample MS-68-30 (Table 4, No. 1), the total quartz contained in the granophyric intergrowth reaches over 10 percent of the rock and the amount of orthoclase approaches 5 percent. In general, however, the quartz content of the gabbro is less than 10 percent. Locally, sufficient potassic feldspar is present to give the rock a pinkish colour (see Table 4, Nos. 1 and 2 for modal analyses). The distribution of grain size, texture, or degree of metamorphism was not found to follow a mappable trend.

OLIVINE DIABASE

The youngest rocks of the map-area are dikes of olivine diabase that cut across most regional structural trends and that are commonly not affected by any late tectonic event. There are, however, locations where these dikes have been offset by late faults or late movement on older faults. The major dike in the map-area strikes at about N70W, and is found in southwestern Stobie Township and east-central Grigg Township. There is a very narrow and apparently short dike with essentially the same strike as the major one, in west-central Grigg Township. Regionally these dikes are up to 15 miles long but seldom over 500 feet wide.

The rock weathers brown with rounded, blocky jointing and, in many places, is deeply eroded to form linear topographic depressions. It is generally unaltered with diabasic texture, composed of plagioclase laths ($An_{50}\pm_s$) up to 3 mm long with interstitial purplish titaniferous augite and olivine, with much accessory apatite and magnetite. The amount of magnetite is variable but generally these dikes contain sufficient magnetite to cause anomalies on airborne magnetic maps (GSC 1965a, b) (see Table 4, Nos. 3 and 4 for modal analyses).

Table 4 MODAL ANALYSES OF POST-HURONIAN ROCKS FROM GRIGG AND STOBIE TOWNSHIPS
(Values in percent)

Analysis Number	Formation and Sample Number	Olivine	Pyroxene	Amphibole	Plagioclase	Granophyre	Saussurite	Magnetite	Chlorite	Sphene	Apatite	Biotite	Plagioclase Composition
	Nipissing Diabase												
1	MS-68-30	...	...	55	1	18	19	7	x	x	...	...	$An_{45} \pm_{5}$
2	MS-68-101	...	...	50	47	2	...	1	...	...	...	...	$An_{55} \pm_{5}$
	Olivine Diabase												
3	BS-68-11	14	12	...	65	...	...	7	...	...	1	1	$An_{40} \pm_{5}$
4	BG-68-9	16	8	...	68	...	...	7	...	...	1	x	$An_{55} \pm_{5}$

x denotes less than 1 percent of mineral present.

CENOZOIC

Pleistocene

Pleistocene glaciation has resulted in both erosional and depositional features in the map-area. As a result, the drainage of the area has been seriously disrupted and has not matured again.

EROSIONAL FEATURES

The most prominent erosional effect in the map-area was the removal of pre-Pleistocene soils by the Pleistocene glaciation. Other erosional features are rounded outcrops which commonly have glacial striae, glacial quarrying on the downstream slopes, and, in very few places, glacial polish. Glacial fluting is found in the Gowganda Formation in northwestern Stobie Township where the strike of the formation and the direction of ice movement were parallel, and in southwestern Stobie Township where ice movement was parallel to schistosity in the Gowganda conglomerate. On many outcrops two directions of glacial striae are present, especially in the southeastern part of Stobie Township. Glacial striae and glacial flutings indicate that glacial movements were predominantly in directions ranging from S8E to S18E for one group and from S22W to S42W for another group. It was not possible to deduce the age relationship of the two phases of glaciation. Boissonneau (1968, p. 103, Fig. 4) shows two ice lobes. He suggests that the two lobes coalesced along a line just north of Grigg-Stobie Townships. Whether the ice lobes were contemporaneous is not known. However, they seem to have coalesced and, therefore, must have been either synchronous or the eastern lobe was slightly younger.

DEPOSITIONAL FEATURES

Glacial deposits consist mainly of a thin veneer of till, sand, and gravel in the areas between outcrops. Large flat areas, such as the area northeast and east of Alphretta Lake, are covered by water-modified deposits of deltaic and kame complexes and extend southward as a channel deposit of outwash sand (Boissonneau 1965). Southeastern Grigg Township and the area just north of Centre Lake in Stobie Township seem to have a thicker than average ground moraine cover. Glacial erratics are found everywhere and they are up to 1,000 cubic feet in size although most of the large ones do not seem to have been moved very far (Photo 9). This makes outcrop recognition, traversing, and mapping difficult. Numerous eskers are found in west-central Grigg Township south and west of Knight Creek. Another small group is present east of the Wanapitei River in northern Grigg Township. A third group of eskers is found around Centre Lake in Stobie Township (see Figure 3).

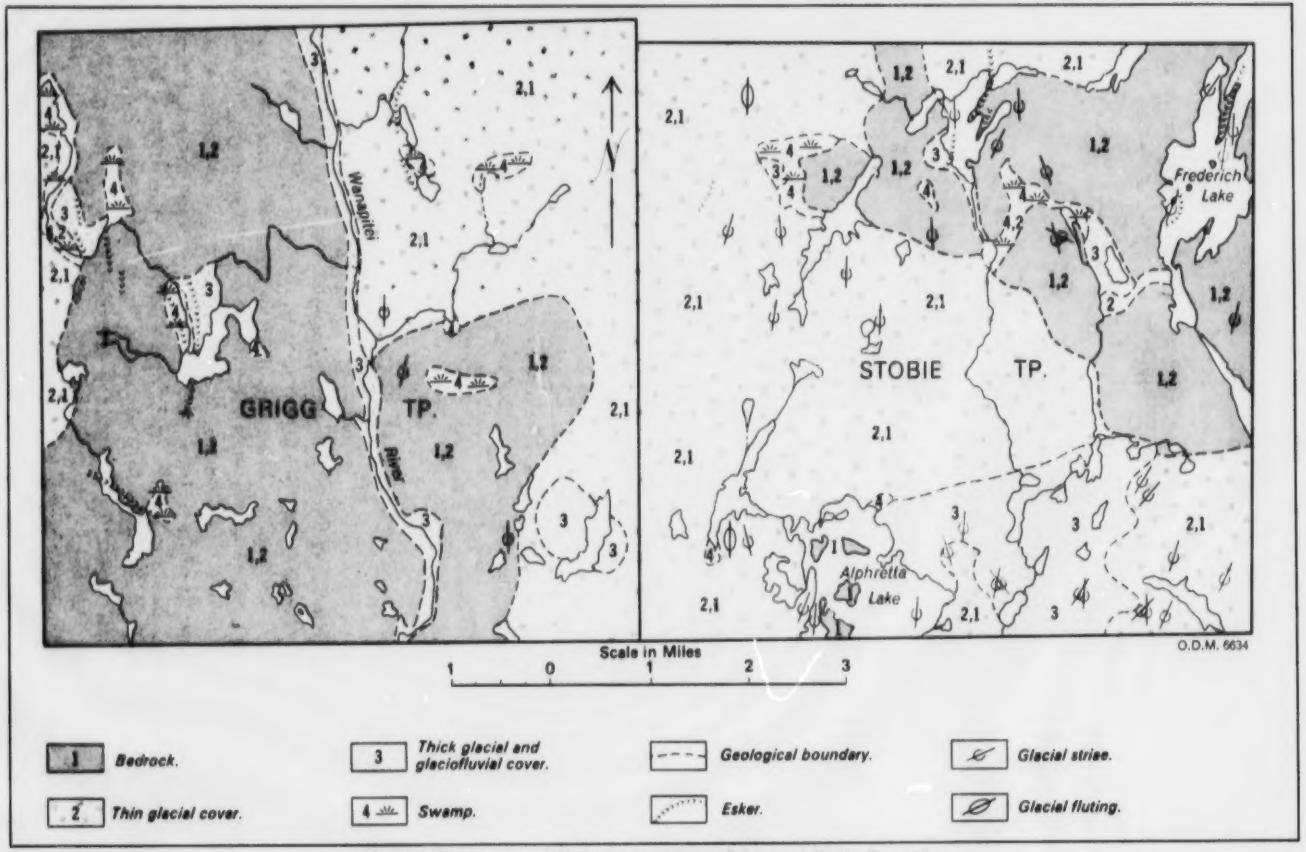


Figure 3–Sketch map of Pleistocene geology, Grigg and Stobie Townships.

ODM8586

Photo 9–Very rough, bouldery terrain exposed by removal of tree cover under the electric transmission line in Grigg Township.

Recent

Recent deposits are fluvial sands and gravels and organic accumulations in swamps. Volume of the present drainage is less than that during the Pleistocene Epoch. It is for this reason that all the present streams are underfit in their valleys, that some of the smaller streams flow in the opposite direction of the Pleistocene drainage, and that others are now reduced to lines of swamps.

STRUCTURAL GEOLOGY

FOLDS

Folds are not a very prominent feature in the map-area. The Archean metavolcanics have undergone strong folding as they now are in a near-vertical position. Because the metavolcanics were intruded by the granitic rocks and are now remnant blocks 'floating' in the latter, the stress pattern for the folds could not be determined. Minor folds occur in the Huronian sedimentary rocks. These folds are reflected by minor changes in dip and (or) strike, however there is an anticline and a syncline in southeastern Grigg Township. Changes in dip and local reversals of dip may have been caused by soft-sediment slumpage rather than major tectonic folding. The change in strike of the Huronian sedimentary rocks in Grigg Township from north-south to east-west probably reflects the rim

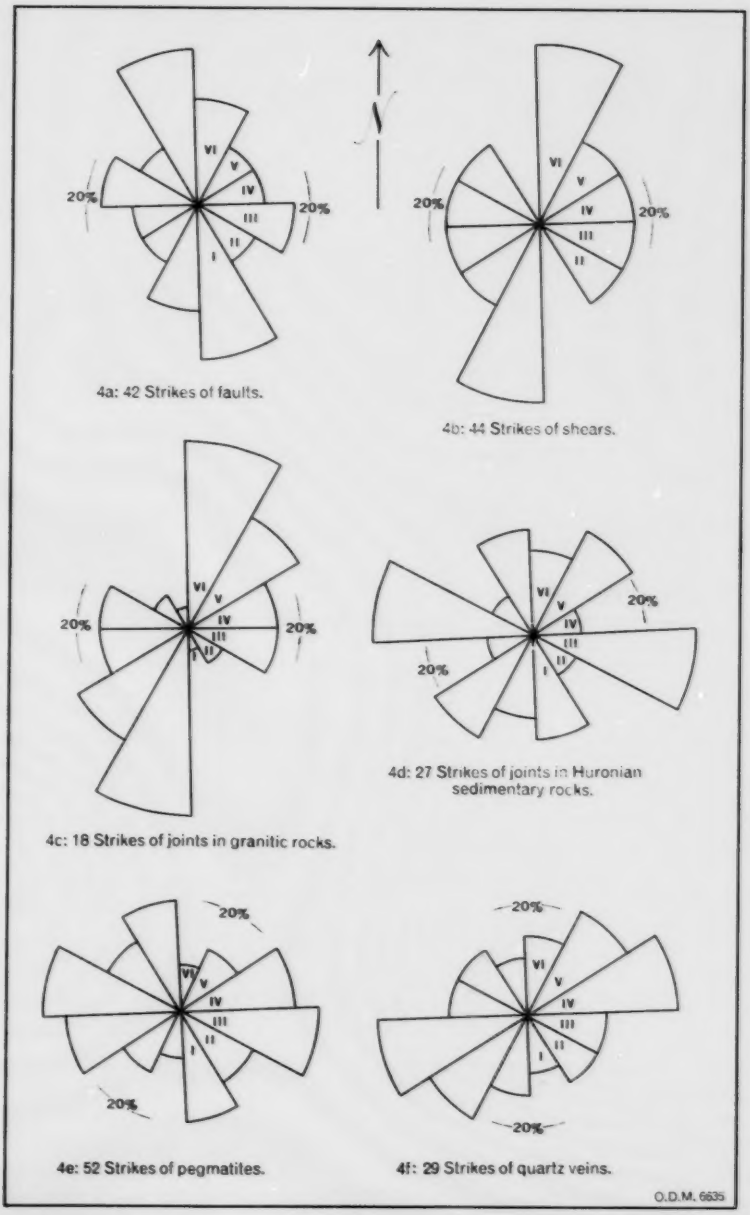


Figure 4—Rose diagrams of some structural features in Grigg and Stobie Townships.

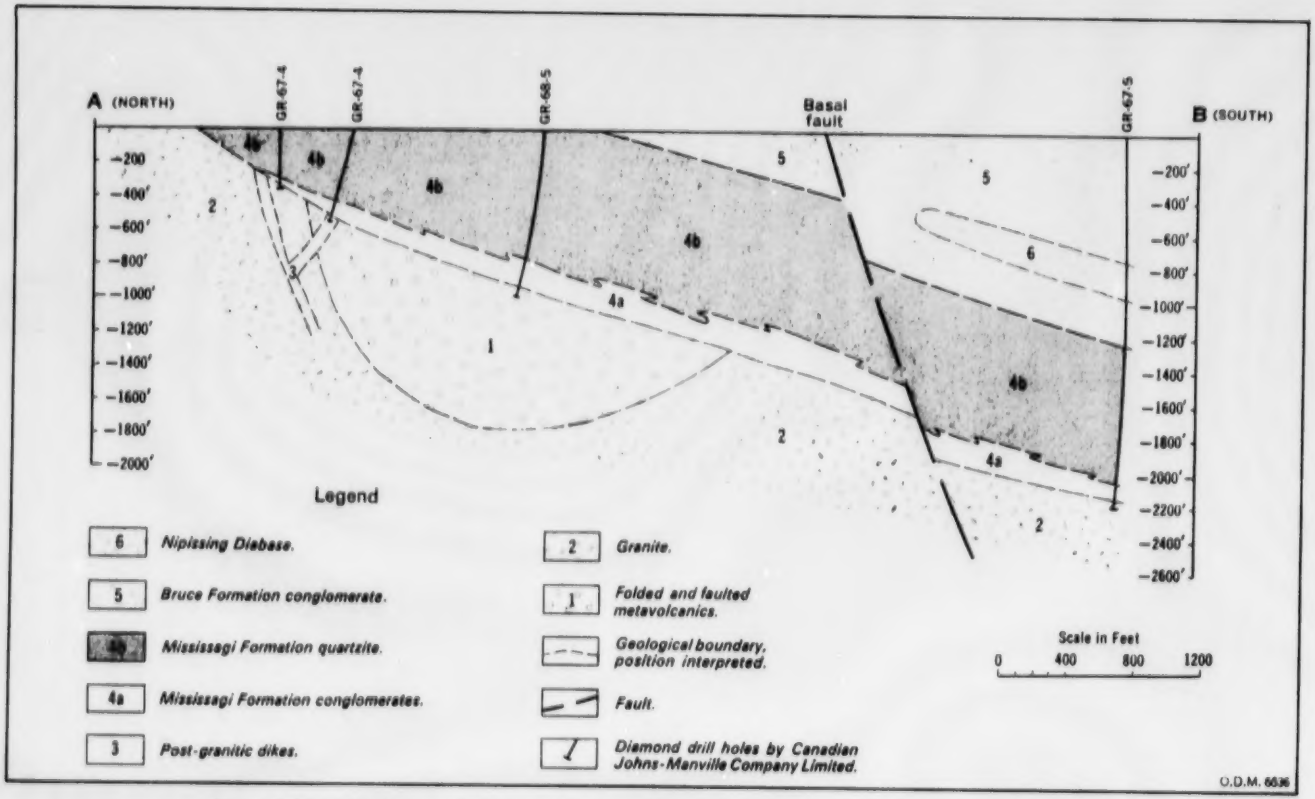


Figure 5–Generalized cross-section of geology, central Grigg Township. Location of section shown on Figure 6.

of the original sedimentary basin rather than postdepositional tectonic events. Information from drill holes indicates that the Mississagi Formation dips nearly vertical against the Upper Wanapitei Fault but has flattened to 40 degrees east, a thousand feet east of the fault. Similar fault-drag folds may exist elsewhere. Folds in the Gowganda and Lorrain Formations are not readily recognized because of the lack of marker horizons.

There are other minor folds at faults, near shear zones, and near diabase intrusions. Small-scale chevron folds were seen in the Gowganda Formation near Alphretta Lake.

FAULTS

Faults form the major structural features of the map-area. The measured structural features of the map-area are shown in rose diagrams in Figure 4. The rose diagrams have been divided into 6 sectors of 30 degrees each. Sector VI, for example, represents a north-northeast south-southwest direction ranging from 357½ to 27½ degrees azimuth; Sector V includes the next 30 degrees from 27½ to 57½ degrees, etc. The odd end points of the sector ranges were chosen because azimuth measurements of structural features in the field were made to the nearest 5 degrees. Figure 4a shows a rose diagram of 42 strikes of faults in the map-area. Sector I is the predominant direction to which the Upper Wanapitei Fault, the Centre Lake Fault, the Balsam Creek Fault, and the Frederick Lake Fault belong.

The Upper Wanapitei Fault is a major regional structure about 40 miles long. In the map-area, it is parallel to other major regional lineaments as shown on Geological Survey of Canada Geological Map 1063A (Wright 1958). Through the length of Grigg Township, the valley of the Wanapitei River is deeply incised with cliffs up to 300 feet high on both sides. Except for the big bend in south-central Grigg Township, the Wanapitei River follows the fault valley. In the northern half of Grigg Township, there is no evidence to determine either the sense or the amount of movement on the fault. In the southern half of the township, the Huronian sedimentary rocks are downdropped on the east side and some basal Mississagi Formation is missing near the fault. The abrupt thickness of Huronian sedimentary rocks on the east side of the Upper Wanapitei Fault is rather noteworthy.

The west side of this downfaulted block has vertically dipping Mississagi sedimentary rocks at surface and at 1,000 feet of vertical depth their dip is apparently still about 80 degrees east (DDH GR-68-6, see Figure 6 for location). A cross-section of the northern part of the block is shown in Figure 5. The vertical scale is equal to the horizontal scale in this figure and, therefore, dips are true dips. The unconformity below the Huronian sedimentary rocks has a dip of over 30 degrees south which is steeper than one would expect. The dip of the top of the conglomerate horizon, which is only about 15 degrees south, may represent a true dip. If this dip is projected southward to the location of GR-68-6, then the base of sediments could have a vertical depth of about 3,200 feet below surface. Combining the evidence from GR-68-6, and a projection from Figure 5, the amount of downdrop on the east side of the fault is a minimum of 1,000 feet, probably 3,200 feet, and possibly more.

A short fault of the Sector I trend has offset the olivine diabase dike in Grigg Township. This indicates that the faults of this set were probably active during and after Huronian sedimentation and again, or still, active after the intrusion of the olivine diabase. The Centre Lake Fault offsets the Lorrain Formation and the Nipissing gabbro just east of Centre Lake but the movement on the fault cannot be determined. It is similarly difficult to analyze the movement on the Balsam Creek Fault. Any offset of the Gowganda-Nipissing contact by the Frederick Lake Fault just south of the northern township boundary could not be determined because the contact is under the water of a lake. The Gowganda-Lorrain contact is also not visible being under the water of Frederick Lake. However farther south on the east side of the Frederick Lake Fault, the Nipissing-Gowganda contact shows offset to the north.

Sectors II and IV appear to belong to a minor conjugate set of faults that are symmetrical about the Upper Wanapitei Fault. The Basal Fault belongs to Sector IV. Rock distribution along the sides of the Basal Fault indicates that the south side has moved down with respect to the north side. Drill holes GR-68-1 and GR-68-2 (see Figure 6 for location) provide some information on the Basal Fault. The dip of the fault is 75 degrees south and 60 degrees south at the two holes, respectively. At GR-68-1 about 750 feet of Mississagi sedimentary rocks are present and their dip is apparently only 10 degrees south, whereas at GR-68-2 only about 50 feet of sheared Mississagi rocks are present. Since there is no surface exposure of Mississagi Formation near GR-68-2 and only about 120 feet near GR-68-1, the Basal Fault must be located near the base of the Huronian. The south side is moved down relative to the north side and the amount of movement seems to be about 500 feet.

Sector III is a major direction of the map-area as shown by faults (Figure 4a), joints (Figure 4d), and pegmatites (Figure 4e). The latest tectonic event in the map-area, the intrusion of the olivine diabase dike, parallels this trend, and is apparently a tensional feature.

Sector VI contains a large number of faults. Pegmatites (Figure 4e) are a minimum in Sector VI and joints in granitic rocks (Figure 4c) are a maximum. This indicates that compressive forces may have acted at right angles to this trend and shearing and possible tectonic transport were active parallel to it.

MINOR STRUCTURES

Joints

Joints are not very conspicuous features in the rocks of the map-area but a number of measurements were made and these plotted in Figures 4c and 4d. Figure 4c shows the joint pattern for the granitic rocks. The feature of major interest here is the maximum in Sector VI which contains a set of shear joints in the granitic rocks. Figure 4d shows a maximum in Section III. This is a set of tension joints because the late regional olivine diabase dikes were intruded parallel to it.

Shear Zones

A plot of shear zones is shown in Figure 4b. This figure is completely dominated by a maximum in Sector VI. This direction is also represented by a secondary maximum in faults (Figure 4a), a maximum in joints in granitic rocks (Figure 4c), and a minimum in pegmatites (Figure 4e).

Quartz Veins

The majority of the quartz veins occur in the Huronian sedimentary rocks. Their strikes are plotted in Figure 4f, which shows a maximum in Sector IV. The quartz veins may indicate a late stress field that predominantly affected the sedimentary rocks. This direction is at right angles to Sector I which is a minimum in Figure 4f. This direction is also a minimum in shears (Figure 4b), but a maximum in faults (Figure 4a). This shows that a direction of maximum stress may have existed parallel to Sector IV and a direction of minimum stress parallel to Sector I at the time (post-Huronian) of the formation of the quartz veins.

Pegmatites

Strikes of pegmatites in granitic rocks are plotted in Figure 4e. The most surprising feature is the maximum in Sector III which coincides with a tensional direction shown by a maximum in joints (Figure 4d) and a tertiary maximum in faults (Figure 4a). This indicates either similar stress patterns in pre-Huronian and post-Huronian times, the formation of these pegmatites in post-Huronian time, or the localization of post-Huronian structures by Archean ones.

CORRELATION BETWEEN GEOLOGY AND GEOPHYSICS

The map-area is covered by Aeromagnetic Maps 1513G, Pilgrim Creek Sheet (GSC 1965b), and 1512G, Milnet Sheet (GSC 1965a). Parts of the map-area are also covered by magnetic, electromagnetic, and radiometric surveys of the Canadian Johns-Manville Company Limited. The company maps are available in the assessment files at the Resident Geologist's Office, Ontario Department of Mines and Northern Affairs, Sudbury and at the Ontario Department of Mines and Northern Affairs, Toronto. As an aid to interpretation, the government aeromagnetic maps were hand coloured at 100 gamma intervals. Intensity differences of only 100 gammas may therefore give rise to the term anomaly.

There is not a strong correlation between the geological and the magnetic maps. A number of highs are present in southeastern Stobie Township and they are apparently caused by detrital magnetite, locally up to 7 percent of the rock, in the thin-bedded Gowganda argillite. A generally northeasterly trend from central Grigg Township to northwestern Stobie Township seems to be parallel

to the strike of the contact between pre-Huronian and Huronian rocks. The weak high in northeastern Grigg Township could be caused by iron formation in a schist complex in the granite. Iron formation is located near the anomaly on the map by Collins (1917) and in a slightly different place on the Maple Mountain Sheet (Donovan 1965), but this iron formation was not found during the mapping. The olivine diabase dike in the southeastern Stobie Township and central Grigg Township causes only a very weak alignment of the contours in the two townships, although the rock contains up to 7 percent magnetite and in other areas causes strong magnetic anomalies. The Nipissing Diabase does not appear to cause any anomaly in the map-area. A magnetic low, recorded just southeast of Stobie Lake, indicates the approximate extent of the Mississagi Formation. The magnetic maps of the Canadian Johns-Manville Company Limited do not aid in the regional interpretation.

The radiometric maps of the Canadian Johns-Manville Company Limited show a weak anomaly centred 350 feet to the east of the surface outcrop of Mississagi Formation on the southeast shore of Stobie Lake. A similar offset appears for the Mississagi Formation on the west shore of Stobie Lake. Near the granitic rock contact, which is outlined approximately by the 500 counts per second contour, a number of weak anomalies are present in the granitic and the sedimentary rocks. Anomalies of up to 18 counts per second are scattered through Gowganda Formation, Serpent Formation, Bruce Formation, Mississagi Formation, and granitic rocks in Grigg Township.

ECONOMIC GEOLOGY

Of economic interest in the map-area is the occurrence of uranium mineralization at the base of the Huronian sedimentary rock sequence. This type of mineralization has been found in both Grigg and Stobie Townships. At present this mineralization does not appear to be of commercial grade, but it is of interest that a favourable stratigraphic setting exists. This setting will be further investigated with regional mapping. Since much of the map-area is covered by rocks of the Gowganda Formation it will be difficult to form a clear stratigraphic picture and to visualize the structural history because of lack of marker units.

Minor amounts of sulphides, essentially pyrite only, are present in the volcanic inclusions in the granitic rocks, in the basal units of the Mississagi Formation, locally in the Bruce Formation, and locally in the Nipissing Diabase. Pyrite cubes are quite common in the Gowganda Formation. Detrital magnetite in the Gowganda argillite may amount to 7 percent and is responsible for an aeromagnetic anomaly and occasionally is remobilized into tiny magnetite veinlets in the sediments.

On Collins' (1917) map a lens of iron formation is shown in western Grigg Township. This could not be found by members of the field party. A small magnetic anomaly to the north of the area indicated by Collins suggests that the iron formation may be mislocated on the earlier maps.

The assessment work data for the map-area, as of December 31, 1968 at the Resident Geologist's Office, Ontario Department of Mines and Northern Affairs, Sudbury, is all filed in the name of the Canadian Johns-Manville Company Lim-

ited. This work consists of 11 diamond drill logs, totalling 8,864 feet, airborne geophysical maps on property in Grigg Township and airborne geophysical maps on property in Stobie Township.

DESCRIPTION OF URANIUM PROPERTIES

There are no patented claims in the map-area. The ownership and approximate location of claims, in good standing on December 31, 1968 are shown on Figure 6.

Canadian Johns-Manville Company Limited (1, 7)

GRIGG TOWNSHIP PROPERTY (1)

In the northwestern corner of the block of claims in Grigg Township owned by the Canadian Johns-Manville Company Limited, some uranium-bearing rocks of the Mississagi Formation are exposed. This mineral occurrence can best be located on Map 2238 (back pocket). The geology of the occurrence is also shown on that map and it is described in the General Geology section. The company has carried out an airborne electromagnetic, magnetic, and radiometric survey on its property. These maps are available in the assessment files, Resident Geologist's Office, Ontario Department of Mines and Northern Affairs, Sudbury. The company also put down 11 diamond drill holes, totalling 8,864 feet, in Grigg Township. The location of the drill sites is shown on Figure 6. No additional information is available for the actual showing. Geiger counter readings of about 1½ times background indicate that radioactive content is very low in the rocks of the showing.

STOBIE TOWNSHIP PROPERTY (7)

Near the southeast shore of Stobie Lake, Stobie Township, another occurrence of radioactive mineralization is present. Here the mineralization is concentrated in a sheared, rusty, argillaceous schist, about 5 feet thick, dipping vertically, with tops facing east, and striking north-south. The geology of the showing is shown on Map 2238 (back pocket) and is described in the "General Geology" section. The Laboratory and Research Branch of the Ontario Department of Mines and Northern Affairs reports an analysis of 0.08 percent U_3O_8 from the sheared argillite and an analysis of 0.021 percent U_3O_8 from a pyritiferous conglomerate. Both rock samples were submitted by the author. No drilling has been done in the area to date, but it is covered by airborne geophysical surveys carried out by the company and the area is slightly anomalous on the radiometric map.

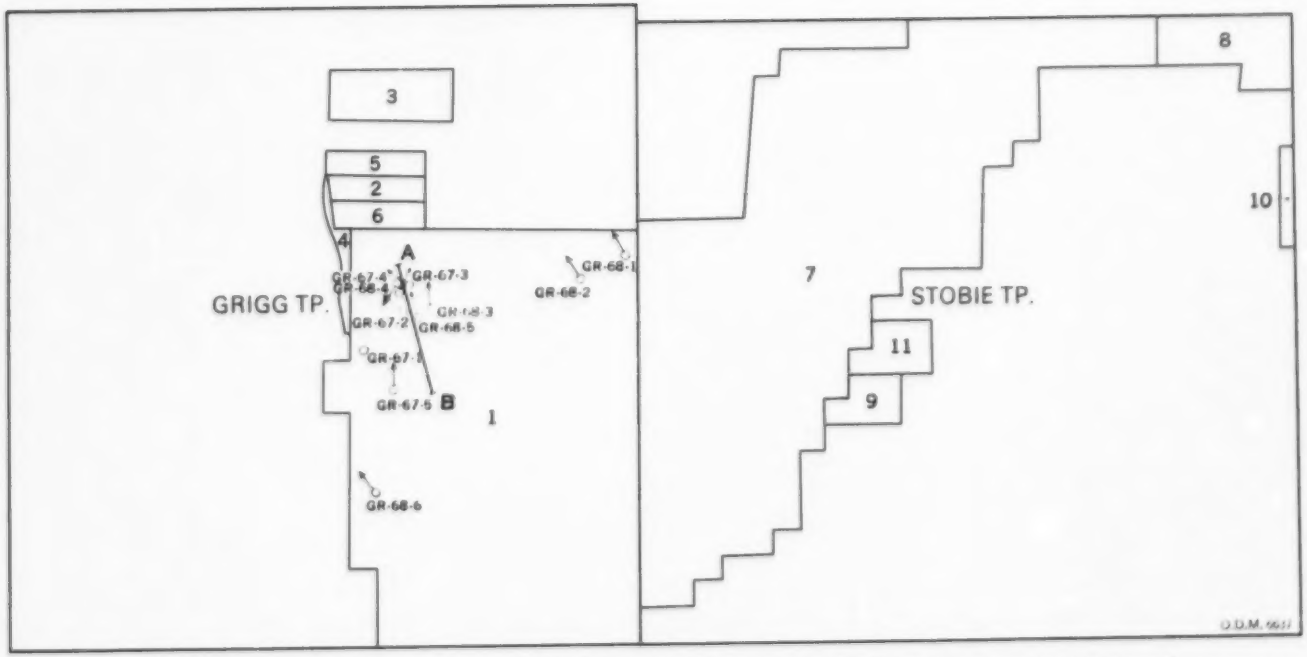


Figure 6–Sketch map of properties in Grigg and Stobie Townships showing locations of drill holes and cross-section A-B, Figure 5.

Grigg Township

1. Canadian Johns-Manville Company Limited, Matheson
2. Caderre, G., Matheson
3. Jarome, A., Jr., Wahnapitae
4. Jarome, A. E., Hanmer
5. Vehkalahti, E., Matheson
6. Winfarer J., Matheson

Stobie Township

7. Canadian Johns-Manville Company Limited, Matheson
8. Ducharme, M., Massey
9. Haley, E., Matheson
10. Theriault, A., Timmins
11. Vehkalahti, E., Matheson

SAND AND GRAVEL

Abundant sand and gravel is available in the area where there are thick Pleistocene deposits or eskers as shown on Figure 3. Minor amounts of sand and gravel can generally be found between outcrop areas. In the steep-sided valley of the Wanapitei River gravel for road construction may be scarce for some distance and it tends to be very near the water-table. Eskers, up to 100 feet above the surrounding countryside, would probably make very suitable and easily mined sources of sand and gravel.

RECOMMENDATIONS FOR FUTURE EXPLORATION

To date only the radioactive mineralization discovered at the base of the Mississagi Formation is of economic interest. The grade of mineralization found has been low and perhaps does not warrant diamond drilling programs, although drilling is probably the only method by which further information with respect to grade and distribution of the mineralization can be obtained.

No evidence of any other mineralization was discovered by members of the field party. Schistose metavolcanic rocks have traces of copper, lead, and zinc mineralization in Parkin and Fraleck Townships (Meyn 1970; 1971).

Quartz-carbonate veins, probably filling shear zones, carry pockets of copper, gold, silver, nickel, and platinum mineralization in Nipissing Diabase near the Upper Wanapitei Fault in Fraleck Township (Meyn 1971) and Rathbun Township (Meyn 1966).

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